

CLAIMS

1. An organic contaminant molecule sensor for use in a low oxygen
5 concentration monitored environment, the sensor comprising an
electrochemical cell comprising a solid state oxygen anion conductor
in which oxygen anion conduction occurs at or above a critical
temperature T_c , a measurement electrode formed on a first surface of
10 the conductor for exposure to the monitored environment, the
measurement electrode comprising material for catalysing the
dissociative adsorption of the organic contaminant molecule, and a
reference electrode formed on a second surface of the conductor for
exposure to a reference environment, the reference electrode
15 comprising material for catalysing the dissociation of oxygen to
oxygen anions; means for controlling and monitoring the temperature
of the cell; and means for controlling the electrical current flowing
between the reference and measurement electrodes, whereby at
temperatures below T_c , organic contaminant molecules are adsorbed
20 onto and dissociated at the surface of the measurement electrode
leading to the build up of carbonaceous deposits at the surface
thereof, and at temperatures above T_c , an electrical current is passed
between the reference and measurement electrode thereby to control
the number of oxygen anions passing from the reference electrode to
25 the measurement electrode to oxidise the carbonaceous deposits
formed at the surface thereof and the formation of carbon dioxide.
2. A sensor according to Claim 1, wherein the measurement electrode
is coated with or formed from material selected from the group
30 comprising rhenium, osmium, iridium, ruthenium, rhodium, platinum
and palladium and alloys thereof.

3. A sensor according to Claim 2, wherein the alloys include one or more elements selected from silver, gold and copper.
- 5 4. A sensor according to any of Claims 1 to 3, wherein the reference electrode is formed from material able to catalyse the dissociation of oxygen.
- 10 5. A sensor according to Claim 4, wherein the reference electrode is formed from platinum, palladium or other metal able to dissociatively adsorb oxygen or any alloy thereof.
- 15 6. A sensor according to any preceding claim, wherein the solid state oxygen anion conductor is selected from gadolinium doped ceria and yttria stabilised zirconia.
7. A sensor according to any preceding claim, comprising a counter electrode positioned adjacent to the reference electrode.
- 20 8. A sensor according to Claim 7, wherein the counter electrode is formed from platinum, palladium or other metal able to dissociatively adsorb oxygen.
- 25 9. A sensor according to any preceding claim, wherein the reference environment is a gaseous source of oxygen at atmospheric pressure, preferably atmospheric air.
10. A sensor according to any of Claims 1 to 8, wherein the reference environment comprises a solid-state source of oxygen.
- 30 11. A sensor according to Claim 10, wherein the solid state source is selected from a metal / metal oxide couple (optionally Cu / Cu₂O or

Pd / PdO), or a metal oxide /metal oxide couple (optionally Cu₂O / CuO).

12. A sensor according to any preceding claim, wherein the means for
5 controlling or monitoring the temperature of the cell comprises a heater and thermocouple arrangement.
13. A sensor according to any preceding claim, further including means for providing a potential across the sensor.
- 10 14. Use of a sensor according to any preceding claim for monitoring the levels of trace organic contaminants in a low oxygen concentration monitored process environment.
- 15 15. A method of monitoring the levels of trace organic contaminants in a monitored process environment, the method comprising the steps of providing an electrochemical sensor comprising a solid state oxygen anion conductor in which oxygen anion conduction occurs at or above a critical temperature T_c , a measurement electrode formed on
20 a first surface of the conductor for exposure to the monitored environment, the measurement electrode comprising material for catalysing the dissociative adsorption of the organic contaminant molecule, and a reference electrode formed on a second surface of the conductor for exposure to a reference environment, the reference
25 electrode comprising material for catalysing the dissociation of oxygen to oxygen anions; exposing the measurement electrode at a sensor temperature T_{ads} to the monitored environment for a time t_{ads} to cause one or more organic contaminant species to be adsorbed onto and dehydrogenate at the surface of the measurement
30 electrode thereby leading to the build up of a carbonaceous deposit at the surface thereof; raising the temperature of the sensor to a value T_{ht} above the critical temperature T_c of the solid state oxygen

anion conductor and passing a current I_p between the reference electrode and the measurement electrode for a time t_p taken for the potential difference across the sensor to reach a constant value determined by the equilibrium between the flux of oxygen anions arriving at the electrode surface and the rate of desorption of oxygen gas from the electrode surface; and determining from the total charge ($I_p t_p$) passed through the sensor at temperature T_{tit} the amount of carbonaceous deposit present at the surface of the measurement electrode and therefore the concentration of organic contaminant species present in the process environment.

16. A method according to Claim 15, wherein, subsequent to the adsorption step, the sensor is heated to a temperature intermediate T_{ads} and T_{tit} to facilitate the complete conversion of any uncracked hydrocarbon contaminant to a carbonaceous deposit on the surface of the measurement electrode, and thereafter the temperature of the sensor is raised to T_{tit} .

17. A method according to Claim 15 or Claim 16, wherein T_{ads} is in the range from 20 to 150°C.

18. A method according to any of Claims 15 to 17, wherein t_{ads} is in the range from 10^2 to 10^5 seconds.

19. A method according to Claim 18, wherein t_{ads} is of the order of 10^4 seconds.

20. A method according to any of Claims 15 to 19, wherein T_{tit} is in the range from 300 to 600°C.

21. A method according to any of Claims 15 to 20, wherein I_p is in the range from 10nA to 100µA.

22. A method according to any of Claims 15 to 21, wherein the sensor is provided with a counter electrode adjacent the reference electrode.

5 23. A method according to any of Claims 15 to 22, wherein the reference environment is a gaseous source of oxygen at atmospheric pressure, preferably atmospheric air.

10 24. A method according to any of Claims 15 to 22, wherein the reference environment comprises a solid-state source of oxygen.

15 25. A method according to Claim 24 wherein the solid state source is selected from a metal / metal oxide couple (optionally Cu / Cu₂O or Pd / PdO), or a metal oxide /metal oxide couple (optionally Cu₂O / CuO).

26. A method according to any of Claims 15 to 25, wherein a potential V_i is applied across the sensor.